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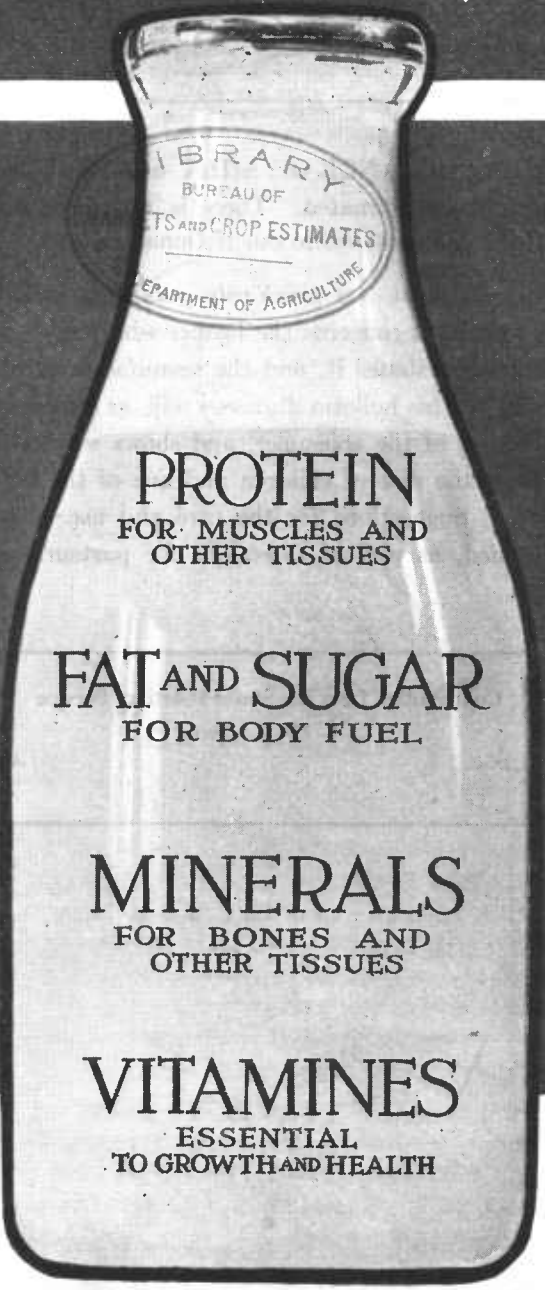
UNITED STATES DEPARTMENT OF AGRICULTURE

MILK AND ITS USES IN THE HOME



THE IMPORTANCE OF MILK as a food can hardly be overestimated. There is no other single food of such vital importance to our national welfare.

This department has previously published bulletins discussing milk as it concerns the farmer who produces it, the dealer who distributes it, and the manufacturers of butter and cheese. This bulletin discusses milk as a food from the point of view of the consumer, and shows why it is indispensable in the diet of children and one of the best foods for adults. Suggestions for the care and use of milk are also included, as well as directions for pasteurizing it at home.

Contribution from the States Relations Service
A. C. TRUE, Director
Washington, D. C. August, 1921

MILK AND ITS USES IN THE HOME.[1]

CONTENTS.

MILK AND CREAM together furnish from 16 to 18 per cent of the total food of the average American family; and even this rather high percentage might well be increased. Children must have milk if they are to develop strong, normal bodies; and there is no better food for adults, especially when combined with such other materials as cereals and green vegetables.

Practically all the milk and dairy products in this country, and in most other civilized countries where the climate is favorable, are furnished by cows. Cow's milk is no better than that of some other mammals, but people have grown accustomed to its flavor and cows make excellent return for the feed and care given them. In parts of the world where cows do not thrive, other milk animals are found satisfactory. Goat's milk, for example, is very common, especially in the rough, hilly districts of Europe, in Central America, and to some extent even in parts of the United States. Buffalo's milk is much used in India, and llama's milk in South America. Camel's milk is esteemed in desert countries, and mare's milk on the steppes of Russia and central Asia. Sheep's milk is used in Europe and elsewhere for making certain kinds of cheese, and the milk of reindeer is commonly used as food in the Arctic regions.

COMPOSITION OF MILK.

Milk as it is drawn from the cow is an opaque, whitish liquid, which varies considerably in appearance and in flavor. It is commonly described as consisting of a thin, bluish-white, somewhat transparent liquid, called the plasma, in which are floating numerous minute yellowish globules of fat. Many analyses show the average composition of milk to be: Water, 87 per cent; protein, 3.3 per cent;

[1] Prepared in the Office of Home Economics, with the cooperation of the Dairy Division, Bureau of Animal Industry.

fat, 4 per cent; milk sugar, 5 per cent; and mineral matter, 0.7 per cent.

Milk is slightly heavier than water, its specific gravity ranging from 1.029 to 1.034 at 60° F. This means that while a quart of water weighs 2 pounds 1⅓ ounces, a quart of milk weighs 1.029 to 1.034 times 2 pounds 1⅓ ounces, or not far from 2 pounds 2½ ounces. The specific gravity depends upon the proportion of water and other substances. Since the fat is lighter than water, the richer the milk is in butter fat the lower its specific gravity, provided, of course, the other solids are not increased proportionally. It follows also that the removal of the fat increases the specific gravity, so that skim milk has a specific gravity of from 1.033 to 1.037.

The freezing point of milk also varies with the composition, falling as the proportion of solids increases and rising as water is added. In average milk it is about 31° F.

PROTEIN COMPOUNDS.

Protein compounds are important nitrogenous ingredients of food indispensable in the formation of body tissues and fluids. They may also be burned in the body to furnish energy. Protein in food takes different forms, for example, egg albumin in the white of egg, myosin in lean meat, and legumin in peas and beans. These forms of protein, both in food materials and in the human body, are made up of various combinations of amino-acids; and the proteins in foods are spoken of as more or less adequate according as they yield a large or small proportion of the amino-acids needed by the body.

The total amount of protein varies somewhat in milk from different cows, but averages about 3.3 per cent by weight of the whole milk. The principal protein compound in milk is casein, which because of its phosphorus content is classified as a phosphoprotein. Albumin, in the special form of lact-albumin, is present in much smaller amounts, being on the average about one-seventh of the total protein. The proportion of albumin to casein varies in the milk of different kinds of animals, of different cows, and also in the milk of the same cow. Both of these compounds are adequate proteins, as are also the proteins found in eggs and meat. There are other nitrogenous substances occurring in milk, but in such small quantities that they need not be considered here.

When sufficient acid is added to milk, or develops in it from the action of the lactic-acid-forming bacteria, the casein is precipitated in light, white flakes. Another kind of precipitation occurs when rennin is added, as in making cheese or junket. This ferment is present in human gastric juice, also in the lining of calves' stomachs, from which it is extracted for commercial purposes. Junket tablets and liquid rennet are preparations containing this ferment.

FAT.

The fat of milk is the most important of its constituents commercially, since it is the source of butter and enters largely into the composition of cheese. This fat, known as butter fat, is made up of different fats, several of which (stearin, palmitin, and olein) are also present in large proportions in the fat from meat, tallow and lard for example, as well as in many vegetable oils. However, butter fat differs from the fats of most other foods in containing also certain volatile acids.

The amount and character of fat in milk varies widely. The amount should not fall below 3 per cent by weight, and except in unusually rich milk does not exceed 5 per cent. It averages about 4 per cent of the milk, or about 31 per cent of the total solids. It is found throughout the milk in emulsified form, that is, in small globules, which vary in size in the different kinds of milk. Since these globules are lighter than water, they tend to rise to the top of the milk as it stands, thus forming cream. Cream is not pure butter fat but contains much fat mixed with smaller amounts of the other ingredients of milk. The cream should measure about one-fifth of the total volume.

MILK SUGAR.

The carbohydrate of milk is lactose, or milk sugar. It is similar in chemical composition to cane sugar, but does not dissolve so readily and is far less sweet. The amount of milk sugar in cow's milk varies from 4 to 6 per cent, the average being about 5 per cent of the total milk, or 38 per cent of the total solids.

Most of the milk sugar remains in the whey when casein or curd is removed in cheese making, and may be easily separated from it. Milk sugar may be obtained in crystals, but is usually marketed as a fine white powder much like confectioners' sugar in appearance. It is used in modifying milk for babies, as a vehicle for drugs, and in many other ways. Its manufacture is an important industry.

MINERAL MATTER.

The ash constituents in milk consist mainly of the phosphates and chlorids of soda, potash, and lime, and make about 0.7 of 1 per cent of the whole milk, or 5 per cent of the solid matter. The ash as a whole is neutral or slightly alkaline, differing in that respect from the ash in the other animal foods.

The three mineral substances in which American dietaries are often deficient, even when otherwise adequate, are phosphorus, iron, and lime, or calcium. Phosphorus in both organic and inorganic forms is relatively abundant in milk. Milk does not contain much iron, but what little is present is in an unusually available form.

Milk is, however, much richer in lime than other common foods (fig. 1). This is one of the reasons why it is such an excellent food for children; it furnishes lime for the building of bones and teeth.

VITAMINES.

Vitamines are recently discovered constituents of certain foods. Relatively little is known about the nature of these vitamines save that they are indispensable for normal health and growth and that if they are left out of the diet for a long period, so-called "deficiency diseases" develop. At least three kinds are now recognized which, until more satisfactory names are agreed upon, may be designated as vitamine A (soluble in fat and sometimes called antirachitic, because the absence of it is believed to induce rachitis, or rickets, in children), vitamine B (soluble in water and sometimes called antineuritic or preventive of polyneuritis and beriberi), and vitamine C (soluble in water and sometimes called antiscorbutic, or preventive of scurvy). All three are present in milk.

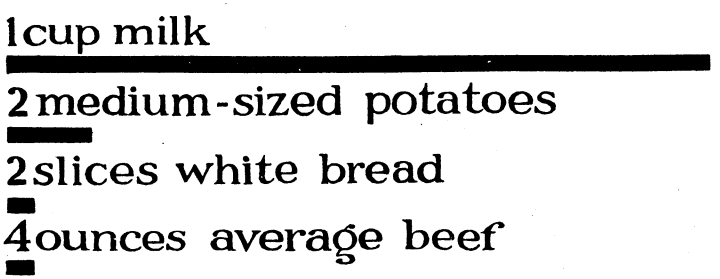


FIG. 1.—Proportions of lime in a cup of milk as compared with those in average servings of some common foods.

Vitamine A is of especial importance for two reasons. One is that without it children can not grow and develop normally, even though their food is otherwise sufficient for their needs. The second reason is that vitamine A is found in such foods as milk, egg yolk, green-leaf vegetables, fats surrounding the vital organs of animals, to a less extent in meat, and perhaps in certain fruits, and in few so abundant as in milk. It appears to go with the milk fat, and so is found in whole milk, cream, and butter.

Vitamine B is found in most foods except those which have been artificially purified, such as white flour, cornstarch, polished rice, refined sugar, and most table oils.

Vitamine C is known to be supplied by certain fruits and vegetables and milk. Its efficacy in milk seems to be easily destroyed, and absolutely fresh, uncooked milk is the only milk that should be relied on to supply it.

VARIATIONS IN COMPOSITION AND ATTEMPTS AT GRADING MILK.

The milk ordinarily sold for household use varies in composition, principally because of differences in the breeds of cows and also in individuals of the same breed. Because of this natural variation, many creameries now test all the milk they buy and pay for it on the basis of fat content. For the same reason dairymen who supply the retail trade usually find it best to mix the milk from a herd of cows immediately after it is drawn. In this way the content of the milk is kept more uniform from day to day, which is a decided advantage to the consumer.

Unprincipled producers or dealers sometimes adulterate their milk, greatly changing its composition. Legislation and Federal, State, and municipal inspection are, however, making it increasingly difficult to defraud the consumer in this way. The chief methods of adulteration are the addition of water, the removal of part of the fat, and the use of chemical preservatives, two of these methods often being used together. These practices not only are fraudulent as regards money value, but also diminish the food value. The specific gravity of milk is sometimes used as a test of its purity, but since removing part of its fat in the form of cream raises and adding water lowers the specific gravity, one form of adulteration may cover up the other and thus render this test alone unreliable. The freezing point method is one of the most reliable for detecting the addition of water to milk.

The chemical preservatives most commonly used are borax, boric acid, salicylic acid, formalin, and soda. They are put into the milk to kill bacteria or hinder their growth. This practice is forbidden by the pure-food legislation enacted by the Federal Government and by most States as well, the most important reasons being that these chemicals may seriously injure health, and that they help to conceal dirty methods.

The commission on milk standards of the New York milk committee appointed to study and recommend uniform requirements among the different States and cities of the United States has recommended the general adoption of the standard calling for not less than 3.25 per cent of milk fat and not less than 8.5 per cent of milk solids not fat. This standard was previously advocated by the Association of Official Agricultural Chemists and has been used by the United States Department of Agriculture for interstate shipment of milk.

If all milk sold could be tested by such a standard, and the price regulated according to whether the milk surpassed or fell below it, both producer and consumer would be better satisfied, the producer because he would get credit for good milk, and the consumer because he would know what he was really buying. Such graded milk is

sold in some European cities, and to a less extent in this country. The principle has been more commonly applied to cream, of which different qualities are sold at prices varying with the amount of fat.

In addition to standards of chemical composition many communities have adopted sanitary or bacteriological standards. The milk is graded according to its purity, and the public thus given some way of judging the quality of the milk purchased.

In some of the large cities "certified" milk may be obtained. The certificate is usually placed on the covering of the bottle. The use of this label is permitted only to those establishments that are certified to by a medical milk commission as to their sanitary conditions and that produce milk conforming in purity to a fixed standard. Such milk justly commands a higher price than that of which the quality is not thus guaranteed. Certified milk is discussed in greater detail in another bulletin of this department.[2]

The term "sanitary" or "special" milk is rather commonly used, being applied somewhat indefinitely to milk produced and handled under conditions considered necessary to secure a pure, wholesome product. It is, however, often applied by dealers, for purposes of advertising, to milk produced under decidedly unsanitary conditions and should not be confused with certified milk.

When milk is passed through a centrifugal separator much of the solid impurities remains in the separator slime. Many people make a practice of using the separated milk combined with the separated cream. On the same principle clarifying machines are used by some dairies to remove the solid foreign particles from milk without separating the cream from it. "Clarified" milk is the term applied to it after this treatment.

FOOD VALUE OF MILK COMPARED WITH SOME OTHER FOODS.

It is a commonplace saying that milk is a perfect food. This may be taken to mean that it contains, first, materials that children need for growth; second, materials that young and old alike need for the repair of their body machinery; and third, materials that all need for fuel, to provide them with heat and with the energy necessary for work. Such a statement should not be understood to mean that milk has these ingredients in such proportions that it can serve satisfactorily as an exclusive food for a grown person or even for a child. To the growing child, however, no other food can satisfactorily replace milk as a part of the diet. Each child should take a full quart of milk each day, but at least a pint without fail.

Iron is a food ingredient that the body needs in greater amounts than are found in milk. This lack is not dangerous for infants be-

[2] U. S. Dept. Agr. Bul. 1, Medical Milk Commissions and Certified Milk.

cause there is a supply of iron in their bodies at birth on which they can draw to supplement the small amount in milk, but older children and adults need more generous supplies, such as can be obtained from egg yolk, meat, whole cereals, and fruits and vegetables, such as prunes and raisins, lettuce, spinach, and beet tops.

That milk is much more than a beverage is not recognized by everybody. The following table shows that, as a source both of energy and of protein, milk ranks with other foods rich in these respects.

Milk as a source of protein and energy.

Protein value.	Energy value.
1 quart of milk contains as much protein as: 7 ounces of sirloin steak. 6 ounces of round steak. 8.6 ounces of fowl. 4.3 eggs.	1 quart of milk yields as much energy as: 11.3 ounces of sirloin steak. 14.9 ounces of round steak. 14.5 ounces of fowl. 9 eggs.

Milk and milk products can be used interchangeably with meats and eggs as a source of protein. A quart of milk contains as much protein as 5 ounces of dried beans or a 12-ounce loaf of bread, and while the legumes and cereals are considered a cheap source of protein it should be remembered that their proteins are not so completely utilized for tissue building as those in milk, meat, and eggs.

Though milk is an extremely valuable food, differing from all others, except possibly eggs, in that it contains fairly good proportions of almost all the ingredients necessary for the building and repair of the body and for supplying the energy for its activities, the ingredients are so diluted with water that a large quantity (5 or 6 quarts each day) would be required to meet the needs of an adult. Also, in order to get the required amount of energy from milk, unnecessary quantities of protein would have to be consumed. Furthermore, healthy digestive organs can do their work better when at least part of the food is in solid form, though even for adults, milk alone can support life for a considerable time, if not indefinitely. The chief value of milk is in combination with other foods.

DIGESTIBILITY.

The amount of nourishment that any kind of food furnishes to the body depends not only upon the food materials that it contains, but also upon how much of those materials the body can actually utilize. Whether milk is to be classed as a digestible or indigestible food will therefore depend upon the proportions of protein, fats, carbohydrates, and mineral matter that the digestive organs of the average normal person are found to transform into material available for the use of the body.

No one element of the various digestive juices, which act upon the food as it passes through the alimentary canal, acts upon all classes of nutrients. All are digested separately, though in some cases at the same time. Since milk contains considerable quantities of each class of nutrients, the way in which it is digested can be better understood by following the changes in each nutrient separately.

The protein compounds are usually considered as giving the most trouble in the digestion of milk, mainly because of the casein. Milk is commonly classed as a liquid food, and so it is until it reaches the stomach. There the rennin of the gastric juice precipitates the casein into a curd from which the other ingredients are separated, much as the whey separates from the curd in cheese making. The acid and the pepsin of the gastric juice together work upon the curd and render a small part of it more soluble, but the bulk of the casein is digested in the small intestine by the trypsin of the pancreatic juice. Experiments [3] have shown that casein which has not been curdled by rennin is more completely digested by trypsin than the curdled casein. Apparently, then, the formation of the curd, especially when tough and leathery, means extra work for the digestive organs. Limewater is sometimes added to milk to prevent such a curd, which is especially likely to form when considerable calcium phosphate is present.

The albumin of milk is for the most part easily digested by either the pepsin or the trypsin.

The digestion of fats depends mainly upon getting the globules into such fine size that they may be easily passed through the walls of the intestines. Separating the fat into such tiny globules is called emulsification. Another change, saponification, also helps in the absorption of fat. The alkaline pancreatic juice unites with the acids of the fat to form a soap, while the glycerin is set free, much as in ordinary soap making. Both the soap and the glycerin are more easily absorbed than the original fat.

The digestibility of any fat depends on the temperature at which it melts, and milk fat, which, as every one knows, grows soft in a warm room and liquefies at about the temperature of the body, is more digestible than those which require more heat to soften them.

The character of the globules may also have some effect on digestibility, and since those in milk are smaller and more easily emulsified than those in other foods, milk fat is considered especially good for invalids and children. The size of the globules varies in milk from different breeds of dairy cattle. There is a theory that the fat of

[3] Archiv. f. Physiol., Nov. 1902, p. 605.

milk containing the larger globules—that is, milk on which cream rises freely, such as the milk from Jersey or Guernsey cows—is less easily digested than that in which smaller globules remain longer in suspension. A mechanical process has recently been introduced by which the globules in milk can be made very small and so mixed through the milk that they will not rise to the surface in the usual way. This is known as homogenization. It does not appear to destroy any of the nutritive qualities of the milk, and seems likely to prove useful in modifying milk for infants and invalids as well as in other ways.

The bulk of the milk sugar is believed to be digested by one of the ferments of the pancreatic juice after it passes from the stomach into the intestines.

It is commonly supposed that the lactic acid of sour milk is changed to simpler bodies in the digestive tract and assimilated, and its presence may be beneficial in checking the growth of putrefactive bacteria that cause intestinal disorders.

Experiments show that the major portion of milk and milk products leave the stomach within an hour and a half.

PROPORTION OF NUTRIENTS DIGESTED.

In connection with the nutrition investigations of the Department of Agriculture, many experiments have been made to determine how thoroughly the protein, fats, and carbohydrates of milk are digested and assimilated, and much similar work has been reported by other investigators. The results obtained vary within rather wide limits, owing either to individual peculiarities of the subject or to conditions under which the milk was taken.

For persons who digest milk well the average coefficients of digestibility may run as high as 98 per cent for protein, 99 per cent for fat, and 99 per cent for carbohydrates. The average values for animal food are 97 per cent protein, 95 per cent fat, and 98 per cent carbohydrates. In general it seems fair to say that milk is on the average as well or even more thoroughly digested than other animal foods.

When milk is the only food eaten by healthy adults, considerably less of the nutrients supplied are assimilated than is the case when it forms a part of a mixed diet. Taking other food with the milk hinders the formation of the lumps of casein in the stomach and so makes the milk easier to digest. Of course, very young children digest mothers' milk alone better than any other food, but this is

because of the peculiarities of their digestive organs, to which such milk is thoroughly adapted by nature, both in composition and in physical properties. If other milk is substituted for mothers' milk it must usually be modified for best results (p. 13). For adults in poor health, milk is commonly an important food, and many individuals whose digestive organs are not in good condition can derive more benefit from it than from any other single food.

COOKED AND RAW MILK.

The heat of cooking produces chemical changes that alter the flavor and appearance of milk. In cooking the milk is raised to a higher temperature than in pasteurization (p. 16). How much these changes affect its digestibility is a point on which authorities differ greatly, for although many experiments have been made to determine the facts of the case, the results are conflicting. The principal changes, apart from the destruction of more or less of the bacteria, are as follows: Part of the protein is coagulated, it is believed, and the protein undergoes cleavage to some extent; that is, the molecule is split up into simpler forms, one of which is a volatile sulphur compound which gives freshly boiled milk its peculiar odor. If the milk is cooked in an open vessel the formation of more or less of a film, or "skin," accompanies the other changes, though it is interesting to note that the formation of this skin and some of the disagreeable features that accompany it may be somewhat hindered by stirring the milk while it is heating. The character of the films formed on milk and other protein solutions has been studied, and the conclusion drawn that the film is probably composed of dried protein with fat entangled in it. The character of the fat globules appears to be somewhat altered by cooking, although the nature of the changes is not yet thoroughly understood. It may be that cooked milk fat is less easily emulsified than raw, but not enough is known to say definitely, and the difference, if it exists, is probably slight. The carbohydrates undergo practically no change unless the heat is continued long enough to caramelize some of the milk sugar. The longer or harder the cooking, the more noticeable are the changes.

Many recent experiments have proved that the curd of boiled milk is distinctly more digestible, although more constipating than the curd of either raw or pasteurized milk. The curd from boiled milk, forms a fine, easily broken-down clot in the stomach.

The effect of heat upon the vitamines of milk is a question of interest. Vitamine C is very easily affected by heat, in fact, even by the ordinary aging of milk. Boiling or pasteurization undoubtedly impairs the slight antiscorbutic property of milk. Infants fed for a long time on boiled or pasteurized milk show a greater tendency to

scurvy than when raw milk is used. It is therefore generally conceded that when boiled or pasteurized milk or milk powder is used in infant feeding, it is safer to supplement it with some uncooked fruit or vegetable juice, and some physicians hold that this is a wise precaution even with raw milk. Recent experiments seem to indicate that the efficacy of vitamines A and B is less easily destroyed, and a temperature of 142° to 150° F. (that used in ordinary pasteurization) does not seem to have a deleterious effect upon them.

MILK FOR INFANTS.

That the best food for infants is milk from strong, healthy women is universally admitted. When this is not obtainable the more nearly the substitute resembles it the better. The milk of the ass and the mare is in many important respects more like human milk than is that of the cow, and their milk used frequently to be given to babies. Goat's milk, too, is highly thought of. At present cow's milk is the most common substitute, and when necessary is artificially modified to make it resemble human milk more closely.

Cow's milk contains more protein, less sugar, and slightly less fat than woman's milk, as shown in the following table:

Average composition of milk of various kinds.

Kind of milk.	Water.	Total solids.	Protein.			Fat.	Carbohydrates (milk sugar).	Mineral matters.	Fuel value per pound.
			Casein.	Albumin.	Total.				
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Woman	88.3	11.7	.....	.....	1.2	3.3	7.0	0.3	285
Cow	87.0	12.8	2.8	0.5	3.3	4.0	5.0	.7	315
Goat	85.7	14.3	3.5	1.0	4.5	4.7	4.4	.8	355
Sheep	81.9	18.1	.....	.....	5.3	7.3	4.7	.9	480
Buffalo (Indian)	82.2	.....	4.3	.5	4.8	7.5	4.8	.8	480
Camel	87.1	.....	3.5	.4	3.9	2.9	5.4	.7	285
Llama	86.6	.....	3.0	.9	3.9	3.2	5.6	.8	305
Reindeer	67.2	.....	8.4	1.5	9.9	17.1	2.8	1.5	930
Mare	90.6	9.9	1.3	.8	2.1	1.1	5.9	.4	190
Ass	90.1	10.4	.8	1.1	1.9	1.4	6.2	.5	205

Cow's milk also has larger fat globules; there is more casein in proportion to the albumin; and the casein is said to form a tougher curd than that of human milk. The deficiency in milk sugar in the cow's milk can easily be made good by adding either milk sugar itself or some other digestible carbohydrate, such as rice flour or arrowroot. The fat globules can be broken down by homogenization (p. 11) and rendered more like human milk. The casein also may be made more easy of digestion by the addition of limewater, or may be artificially predigested by peptonizing or by boiling, but nothing can exactly reproduce the protein of human milk. For this reason perhaps more than

for any other, cow's milk, no matter how skillfully modified, is never quite so satisfactory as human milk for infants.

Fortunately, most healthy babies thrive on good cow's milk or cow's milk simply modified. It is the sickly who require special preparations, and their needs vary so greatly that only the physician acquainted with the case, and not always he, can say what change is necessary. There are laboratories in many large cities and towns where modified milk of all sorts can be procured on prescription.

All babies fed on raw cow's milk are in more or less danger from the undesirable bacteria which it may contain and which cause diarrhea and other serious infant disorders. The methods of pasteurizing and sterilizing milk to avoid this danger are discussed on pages 16 to 19. When raw milk is used great pains should be taken not only to obtain fresh, clean milk from tuberculin-tested cows, but also to care for it scrupulously after it is purchased. It is usually more important that the milk should be pure than that it should be rich in cream, especially as the fat in very creamy milk may be less digestible on account of the size of the fat globules. Specially "certified" raw milk produced and bottled under strictly sanitary conditions is for sale in most large cities, necessarily at a high price to cover the expenses of rigid inspection.

BACTERIA IN MILK.

Besides the chemical compounds, milk also contains large numbers of minute organisms called bacteria. Few, if any, are normally present in the milk within the udders of clean, healthy cows, but they are so abundant everywhere in the air, especially about the stable and barnyard, and cling in such numbers to the bodies of the cows, that they are almost always found in milk as soon as it leaves the udders or even just inside the teats. Utensils that have not been sterilized are another very common source of bacteria in milk. Bacteria reproduce very rapidly in a favorable medium, such as warm milk, and the number present becomes very large unless measures are taken to hinder their increase. The amount in milk of a given age varies of course with the conditions.

A great many kinds of bacteria have been found in milk, each of which occasions a special set of changes as it develops. Perhaps the most prevalent kinds are those that cause the ordinary souring of milk and are the first to produce any noticeable change in the taste and odor. In their growth they feed upon the milk sugar and convert it into lactic and volatile acids, which give slightly soured milk its peculiar taste and odor. When enough of this lactic acid has formed it acts upon the casein, causing it to separate into loose, light flakes and to form, upon standing, the ordinary "clabbered" milk. Other bacteria developing in sour milk may give it a strong,

unpleasant odor or flavor, and still others, which occur occasionally color it very brightly or give it a slimy or ropy consistency. Some of the products of bacterial action on milk are desirable, however, for instance those that give to butter and cheese the characteristic flavors and odors.

Since there is frequently more or less dirt in freshly drawn milk, most of it fine particles of litter and manure that fall into the pail from the body of the cow, milk should always be strained directly after the milking is over. Of course the amount of dirt varies with the condition in which the cow and her surroundings are kept. Under ideal dairy conditions only very small quantities are found, while milk from untidy establishments may contain enough in a quart to form a noticeable sediment. Milk with enough dirt to be visible indicates a badly kept dairy and should not be tolerated. Moreover visible dirt does not tell the whole story; some of the manure that falls into milk is dissolved and it sometimes carries disease-producing bacteria. Consumers should always insist upon having clean milk, and they should also remember that cleanliness should not stop at the dairy but should be scrupulously maintained at every step of the way to the final consumption of the milk.

MILK AS A CARRIER OF DISEASE GERMS.

Disease germs may get into milk either directly from a diseased cow or indirectly from an infected person, from polluted water, or in some similar way. It is certain that the tubercle bacillus, the germ that causes tuberculosis, does sometimes exist in milk from tuberculous animals; whether or not persons who drink such milk may become infected by it, is extremely hard to prove. There are many other possible sources of contagion, and the disease develops so slowly that by the time it is recognized it is usually too late to trace the cause. Nevertheless there is enough evidence that the disease may be carried in this way to make the use of milk from tuberculous cows too dangerous to be tolerated.

Among the contagious diseases to which the cows are not liable but which may be spread by milk, the most common are perhaps scarlet fever, typhoid fever, and diphtheria. Statistics show that milk is sometimes the cause of an epidemic of such contagious disease, and occasionally a serious epidemic may be traced to the milk from a single farm. The bacteria causing these diseases may enter the milk from contaminated water used in washing milk utensils or containers, or from persons handling the milk who have been exposed to the disease or who harbor the germs in their own bodies. For this reason only water known to be pure should be used about the dairy or kitchen even for washing and rinsing, and no person who has any such disease or is caring for another person suffering from it should be allowed about the cows or the milk utensils.

Milk that is left exposed to the open air invites contamination not only from bacteria-laden dust but from flies. These insects may convey germs of typhoid fever or other contagious diseases from the sick room or from excreta to the milk. As many as 100,000 fecal bacteria have been found on a single fly.

PASTEURIZATION AND STERILIZATION.

Slight warmth is very favorable to the growth of bacteria, but intense heat is fatal to them. Unfortunately, heat sufficient to destroy all varieties of bacteria also causes changes in the chemical composition and flavor of milk, as seen in boiled milk (p. 12); otherwise cooking would be a very simple and satisfactory way of preserving milk. Pasteurization is a common method of applying heat so as to destroy as many bacteria as possible without producing undesirable changes in the chemical constituents. Most large cities now require that all except specially certified milk be pasteurized before sale.

In pasteurizing, milk is generally heated to 145° F. and held at this temperature for 30 minutes and then rapidly cooled. This treatment does not render milk sterile, though when done by the best commercial method it destroys about 99 per cent of the bacteria present and considerably delays souring. While efficient pasteurization destroys disease germs such as those of tuberculosis, diphtheria, typhoid fever, and pathogenic streptococci, it should not be regarded as an insurance against future contamination, and as great care should be taken of pasteurized as of unpasteurized milk.

HOW TO PASTEURIZE MILK AT HOME.

Milk and cream for ordinary use or milk for feeding infants may be successfully pasteurized at home. The process is not difficult and requires only simple equipment. A pail somewhat deeper than the bottles containing the milk and with a perforated false bottom is perhaps the most convenient utensil in which to heat the milk. An inverted pie tin with a few holes punched in it serves very well as the false bottom, its purpose being to raise the bottles from the bottom of the pail, allowing free circulation of water and preventing the bottles from bumping. A good thermometer with the scale etched on the glass is needed. The ordinary floating dairy thermometer is likely to be inaccurate.

For general use, milk is most conveniently pasteurized in the bottles in which it has been delivered. Pour out a little of the milk, replace the covers, punch a hole through the cap of one of the bottles, and insert the thermometer. Set the bottles of milk in a pail, fill with cold water nearly to the level of the milk, and heat the con-

tents until the thermometer in the milk registers 145° F. Remove the pail from the flame and allow the bottles to remain in the water for 30 minutes, reheating if necessary to maintain the temperature

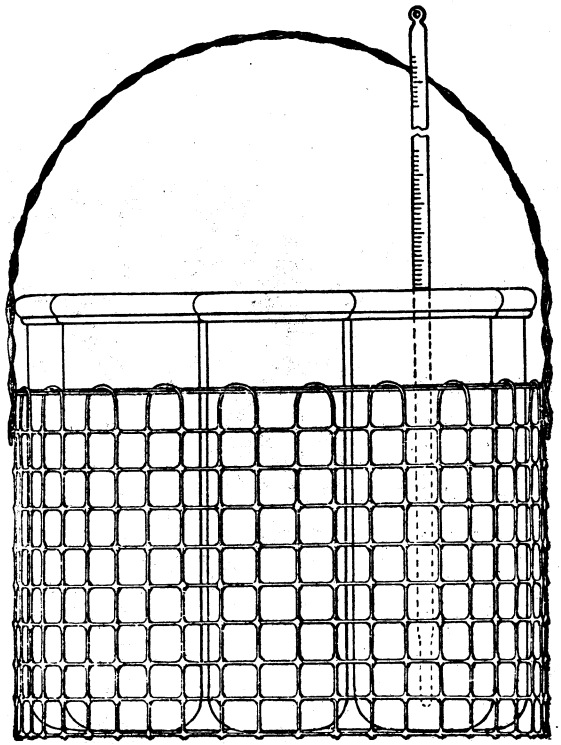


FIG. 2.—Wire basket with nursing bottles of milk ready for pasteurization. The bottles are covered with tight-fitting rubber diaphragms which should be left on until the milk is used.

of 145°. After the 30-minute period, replace the hot water gradually with cold until the temperature of the milk is reduced to 50° F. If necessary use ice in the water to bring the milk to this temperature. After cooling, put the bottles in the refrigerator and keep them at 50° F. or less.

Milk for infants is best pasteurized in the nursing bottles in the quantity needed for each feeding. It is then in the most convenient form to use, and there is no possibility of contamination by pouring it into other bottles. It is customary to pasteurize enough at a time to last for 24 hours. Milk in these smaller bottles is pasteurized by a slightly different method than it is in ordinary bottles. A wire or tin basket (fig. 2) that holds the bottles upright in the hot-water bath

and makes it possible to handle them all at one time and without scalding the fingers is a great convenience.

Pour into each bottle the exact quantity of milk required for a feeding, after modifying it, if necessary, according to directions. It is wise to prepare an extra bottle, for there is always the possibility that one may be broken during pasteurizing. Adjust the seals, or plug the tops of the bottles with clean ordinary (not absorbent)

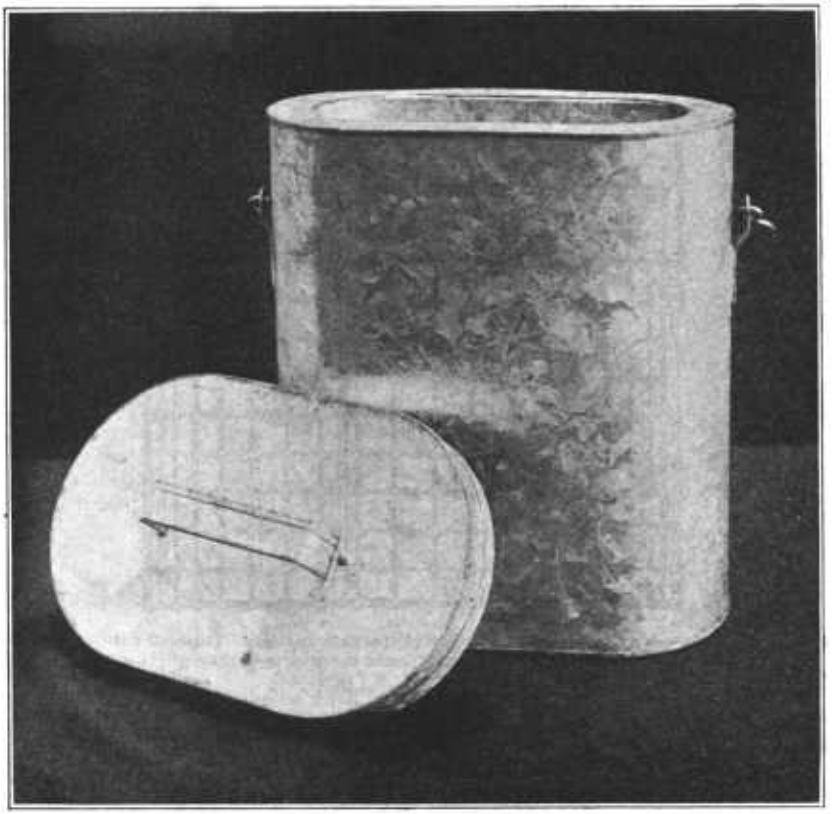


FIG. 3.—Porch box for keeping milk cool and protected when delivered. As soon as possible the milk should be placed in the refrigerator. This box consists of two galvanized iron cases between which is a layer of insulating material.

cotton, and insert the thermometer in one of them. Place the bottles in the wire basket, set it in the pail, fill the pail with water nearly to the level of the milk, and heat until the thermometer in the milk registers 145° F. Remove the bottles, change the thermometer from the milk to the water, and add cold water until the temperature of the water is also 145° F. Put the bottles back into the water, cover them with an old bath towel or other heavy suitable cloth, and let them stand for at least 30 minutes. Then cool them as much as

possible by running cold water into the pail, and store them in the refrigerator, or still better pack broken ice about them before putting them in the refrigerator. Remove the milk, bottle by bottle, from the refrigerator as needed. If a bottle is warmed and not used, discard it; do not return it to the refrigerator to be used later.

CARE OF MILK IN THE HOME.

No matter how well milk has been handled up to the time it is delivered to the consumer, it can not be expected to keep well if it is then carelessly treated. Milk should be kept clean, covered, and cool;

FIG. 4.—Delivering milk into the porch box.

these three points, consumer as well as producer should never disregard.

In towns and cities the best way of buying milk is in bottles. In this form it can be kept clean and cool more easily during delivery and is much more convenient to handle. Dipping milk from large cans and pouring it into customers' receptacles on the street, with the incident exposure to dusty air, is bad practice. Drawing milk from the faucet of a retailer's can is not quite so bad as dipping, but the milk is not kept thoroughly mixed and some consumers will receive less than their share of cream. By whichever of these methods the milk is measured, it should be delivered personally to some member of the household, if possible, or a covered vessel may be set out, such as a bowl covered with a plate, or better still a glass jar, used for no other purpose, with a glass lid but without a rubber. Under no circumstances should an uncovered vessel be set out to collect

thousands of bacteria from street dust before the milk is poured into it. Money and paper tickets are often more or less soiled; hence neither should be put into the can, bowl, or jar.

Sometimes milk delivered as early as 4 o'clock in the morning remains out of doors in a place exposed to sunshine and perhaps accessible to cats and dogs until 9 or 10 o'clock. This is wrong. If the milk can not conveniently be brought into the house at once, the delivery man should be asked to leave it in a sheltered place or in a covered box provided for the purpose (figs. 3 and 4). Even a temporary rise in the temperature of milk will help the development of bacteria that have been held in check by keeping the milk cool, and domestic animals rubbing against a milk container may contaminate it with bacteria dangerous to health.

As soon as possible after delivery, milk should be put in a cool, clean place and kept there until used. It deteriorates by exposure to the air of pantry, kitchen, or nursery. Unless it is in the bottle into which it was put in the dairy, it should be poured into a freshly scalded vessel and covered.

The best temperature for keeping milk is 50° F. or less, and good milk kept that cool should remain sweet for 12 hours at least and ordinarily 24 hours or more, after it reaches the consumer. If ice can not be obtained, an iceless refrigerator or some such device is a help even though a temperature as low as 50° F. can rarely be maintained in it.

In the ordinary refrigerator, unless the milk container is in actual contact with the ice, the milk will be colder at the bottom of the refrigerator than in the ice compartment, for cold air settles rapidly. The refrigerator should be kept clean and sweet at all times. Inspecting it thoroughly at least once a week is a good plan, to see that the outlet for water from the melting ice is open and that the space under the ice rack is clean. Also the food compartments should be scalded every week. A single drop of spilled milk or a particle of neglected food will contaminate a refrigerator in a few days.

Sometimes in very hot weather housekeepers complain that, in spite of all precautions, milk sours quickly, even in the refrigerator. This is often due to the fact that the air of the refrigerator, although cool in contrast with the heat outside, is really not cold enough to check the growth of the bacteria in the milk. If a thermometer placed inside registers more than 50° F., the fault can not be laid entirely to the quality of the milk.

Milk should be kept covered to exclude not only dirt and bacteria but also flavors and odors, which it readily absorbs. It should be kept away from foods of strong odor, such as onions, cabbage, or fish.

Bottled milk should be kept in the bottle in which it is delivered until needed for use. In fact from a sanitary standpoint, serving milk on the table in the original bottle is excellent practice. In any case a milk bottle, especially the mouth, should be cleaned carefully before the milk is poured from it, and only what is needed for immediate use should be poured out at a time. The bottle should be kept covered with a paper cap or an inverted tumbler as long as there is milk in it.

New milk should never be mixed with old unless it is to be used at once; the old milk is likely to contain a larger proportion of bacteria.

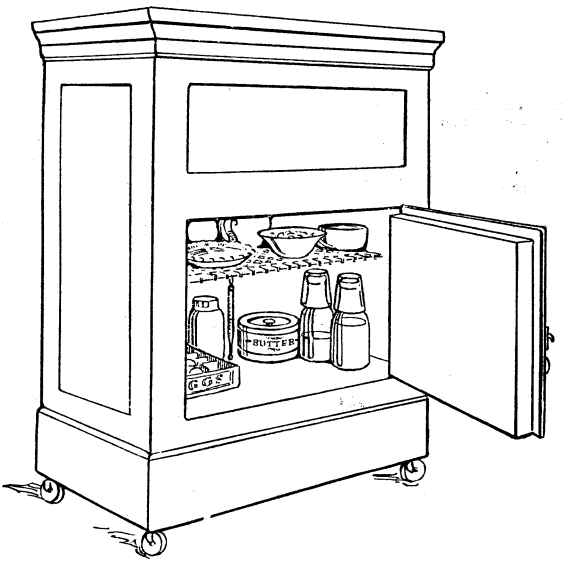


FIG. 5.—Proper arrangement of foods in a refrigerator. Milk, butter, and eggs are in the coldest part, and cooked foods of pronounced odor on the upper shelf.

Some persons even go so far as to say that milk or cream that has been exposed to the air by being poured into other vessels for table or cooking use should not be poured back into the general supply.

As soon as a milk bottle is empty, it should be rinsed first in cold and then in warm water until it appears clear; then set bottom up to drain. It should not be used for any other purpose than for milk.

All utensils with which milk comes in contact should be rinsed in cold water, washed, and scalded with water at or near the boiling point every time they are used. It is a good plan to set them away unwiped. In no case should they be cleaned in water that has been used for other utensils, or wiped with a towel that has been used for other dishes since it was scalded.

MILK PRODUCTS.

From the large number of analyses of milk and milk products reported by the agricultural experiment station chemists and other investigators the following data showing the average composition of these materials have been compiled:

Average composition of milk and milk products.

Item.	Water.	Protein.	Fat.	Carbohydrate.	Ash.	Fuel value per pound.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Whole milk	87.0	3.3	4.0	5.0	0.7	315
Skim milk	90.5	3.4	.3	5.1	.7	165
Cream	74.0	2.5	18.5	4.5	.5	880
Buttermilk	91.0	3.5	.5	4.2	.8	160
Whey	93.0	.8	.3	4.8	.7	115
Condensed milk, sweetened	28.0	7.8	9.0	53.5	1.7	1,480
Condensed milk, unsweetened	73.0	7.0	8.0	10.5	1.5	645
Skim-milk powder	4.0	35.0	2.0	56.0	8.0	1,640
Whole-milk powder	4.0	25.5	29.0	36.0	5.5	2,300
Butter	13.9	1.1	83.0	.....	3.0	3,410
Cheese (American, cheddar)	23.5	26.6	35.5	1.5	3.5	1,950
Cheese (Swiss)	31.4	27.6	34.9	1.3	4.8	1,950
Cottage cheese (skim milk)	69.8	23.3	1.0	4.0	1.9	535
Kephir	89.6	3.1	2.0	4.5	.8	220
Koumiss	90.7	2.2	2.1	4.1	.9	200

SKIM MILK.

When whole milk and skim milk are compared, it will be seen that though the latter is deficient in fat, this is not the case as regards protein, carbohydrates, and ash. Even after average milk is skimmed—that is, after the bulk of the fat is removed—the remaining solids, or nutritive ingredients, still make up nearly one-tenth of its weight.

In the ordinary mixed diet a sufficient amount of fat is supplied by meat, butter, lard, and in various other forms, so that the loss of this ingredient is of relatively little importance. Protein, on the other hand, is the most costly of the food ingredients and the one most likely to be lacking in inexpensive meals, and this is the nutrient that skim milk supplies in a cheap and useful form. The value of skim milk as food is not fully appreciated. It is not so rich in flavor as whole milk, but when taken with bread or used in cooking, it forms a very nutritious addition to the food. A pound of lean beef (round steak, for example) contains about 0.18 pound of protein and has a fuel value of 870 calories. Two and a half quarts, or 5 pounds, of skim milk will furnish nearly the same amount of protein and have about the same fuel value as the pound of round steak. Two quarts of skim milk have a greater nutritive value than a quart of oysters; the skim milk has 0.14 pound of protein and a fuel value of 680 calories, while the oysters contain only 0.12 pound of protein and have a fuel value of 470 calories.

In some localities fresh skim milk of good quality is sold under its real name and at a reasonable price, but in other places its sale is forbidden as a protection to consumers.

CONDENSED AND EVAPORATED MILK.

When milk is heated the water in it evaporates readily, and if the heating is continued long enough, the milk becomes thick and creamy. This fact is taken advantage of in the manufacture of condensed and evaporated milk. On a commercial scale the process is commonly carried on in vacuum pans, as under such conditions a lower degree of heat may be employed and the danger of scorching is lessened.

Commercial condensed milk is usually made by adding to fresh milk large quantities of cane sugar, heating the milk to dissolve the sugar, and then evaporating the whole until its bulk is from two-fifths to one-third that of fresh milk or less, and its sugar content approximately 42 per cent by weight. It is sold in cans of varying size as sweetened condensed milk and its manufacture is an enterprise of very great importance. The low water content and the large percentage of sugar do not favor bacterial growth; therefore condensed milk will keep for a reasonable time after the cans are opened although it is not sterilized in the canning.

Condensed milk is used in many ways like fresh milk or cream. When properly diluted with water it may be used in cookery like ordinary milk and is very satisfactory, especially on shipboard, in the Tropics, or in other places where fresh milk can not be readily obtained. The small bulk is an additional advantage in shipping.

Evaporated milk, as known in the trade, is whole milk that has been condensed in a vacuum pan to about one-half of its original volume without the addition of sugar. After it is drawn from the vacuum pan it is put through a homogenizer to break up the fat globules so that they will not separate on standing. The milk is then placed in sealed cans and exposed to steam under pressure. The temperature must be sufficiently high and the exposure long enough to destroy all bacteria in the milk. In this process a soft curd is usually formed, and after the milk has cooled the cans are shaken vigorously to break up this curd and give the milk a creamy consistency. If properly made, evaporated milk is a sterile product and will keep unopened indefinitely. After opening it must be handled carefully, for like fresh milk it is liable to contamination and is an excellent medium for the growth of bacteria.

DRY MILK OR MILK POWDER.

Within recent years special devices have been put on the market for evaporating milk to a fine powder, which is easy to keep, nutritious, and, of course, convenient for shipment. Skim-milk powder was the first type produced in this country and is still the principal

form on the market, but powder is now also made from whole milk,[4] half-skim milk (whole milk with one-half the fat removed), and buttermilk. Skim-milk powder has much better keeping qualities than whole-milk powder as the fat in the latter is likely to become rancid on keeping. When water is added to these powders the resulting mixture closely resembles the original milk in appearance and may be used in cookery and in other ways. The flavor depends to a great extent upon the method of manufacture, in some cases being almost the same as that of fresh milk, while in other cases a slightly strong or scorched taste is present, but is not pronounced enough, it is said, to be noticeable in cooked products in which it is used.

RECONSTITUTED MILK.

Reconstituted milk is the product obtained by assembling and blending together by means of a centrifugal machine the constituents existing in the milk before separation or drying. It is made from sound sweet unsalted butter, sound sweet skim-milk powder, and fresh water; or it may be made from evaporated or skim milk as a base with any additional preparation of butter fat to give the desired richness of milk or cream.

CREAM.

Cream contains the same constituents as milk, the chief difference being that the proportion of fat is greater in cream. Used in the making of puddings, cakes, soups, and other products, or when served in combination with cereals, fruits, or desserts, it not only improves the flavor but materially increases the fat content, or the "richness" of the dish.

Judging by available data, cream in large quantities is less easily digested than the same amount of whole milk, because it contains so much fat; on the other hand, it is more thoroughly digested than most other forms of fat, and is often ordered by physicians when more fat is needed in the diet. At usual prices it is so expensive that it must be considered a luxury to most people who purchase their milk and cream.

Much of the cream sold is pasteurized before sale. The heat of pasteurization causes cream to lose some of its body and sometimes to separate slightly so that many dairies make a practice of homogenizing their cream before pasteurization. By this process the fat globules are made so fine that they show no tendency to rise to the surface.

[4] Under the food and drugs regulations, dried whole milk must be the product resulting from the removal of water from milk and must contain not less than 26 per cent milk fat and not more than 5 per cent of moisture.

Whipped cream is the product obtained by incorporating air into cream by beating. If the whipping is too long continued, the fat globules collect and form butter instead of remaining in the form of an emulsion. Cream for whipping should contain preferably 30 per cent or more butter fat. It will whip more easily if chilled to a temperature of 35° or 40° F. Moreover, it should be at least 12 hours old, or, better, 24 hours; for as it ages its fat globules tend to run together, and also a slight acidity develops which affects the nitrogenous constituents in such a way that the cream becomes more viscous, or sticky. Both pasteurized and unpasteurized cream can be whipped successfully under the proper conditions of age, acidity, and temperature. Because of the change in the character of the fat globules, homogenized cream is difficult to whip, and if it contains only 18 to 20 per cent fat, it can not be whipped satisfactorily.

Sometimes difficulty is experienced by the housewife in whipping cream, especially if it is somewhat thin. In some cases, this is due to the freshness of the cream, and the addition of a small quantity of lactic acid or, in household use, a small amount of sour cream will remedy the trouble and will not be noticeable in the finished product. The addition of one-half teaspoon of vinegar or lemon juice to a cup of cream will have the same effect, or sometimes a little bit of sucrate of lime, commercially known as viscogen, is added.

A cream product known as "Devonshire clotted cream," or simply as "clotted cream," and very popular in England and, to a less extent, elsewhere, is made by scalding pans of milk on which the cream has been allowed to rise and remain undisturbed. When this is properly done, and the pans of milk allowed to cool, the cream may be taken off in a thick, clotted condition, and is ready for use. It has a peculiar, nutty flavor, which most persons relish and which combines especially well with fruits.

BUTTER.

Butter, which is practically separated milk fat, is one of the most important sources of fat in our diet and certainly one of the most palatable and digestible. Moreover it also has a special dietary value because it contains the vitamine necessary for growth. The flavor of butter depends upon such factors as volatile fats, cleanliness, the action of bacteria, and the amount of salt added. Flavor, color, and texture, which influence price to some extent, are factors affecting quality rather than composition, and so far as is known have little effect on nutritive value or digestibility.

The butter on sale in the United States is usually salted, partly because of the general preference for the salty taste and partly because of improved keeping qualities. It is noticeable that butter

is now less heavily salted than was the case before cold storage and such facilities for keeping foods became common. In Europe sweet, or unsalted, butter, which has a mild, creamy flavor, is most commonly used and its popularity is growing in the United States. Since it does not keep well, it must be used soon after it is made, and ranks as a delicacy. Some persons make sweet butter at home as needed, using for the purpose an egg beater or one of the devices similar in principle which are on the market for this purpose.

A peculiar form of butter, called "ghee," is commonly used in India and central Asia. The water is boiled out from freshly made butter, and the resulting product is kept for general use, especially in cooking. In the cold, high regions of Tibet it is used in large quantities, lumps of it being put even in tea. This product is very similar to the rendered butter used by orthodox Jews in kosher cookery. Rendered butter is also a common culinary fat in Egypt and some other countries.

More detailed information concerning butter and its economical use in the home is given in another publication of the department.[5]

BUTTERMILK.

Buttermilk is an important by-product resulting from the manufacture of butter. In butter making the fat globules are brought together by churning and removed, leaving a thin liquid, much like skim milk in composition and usually with a mild acid taste, because the cream is generally allowed to sour before churning. Buttermilk is also made from skim milk or milk of low fat content that is pasteurized and then ripened by the use of pure cultures until the desired acidity is obtained. The sour milk is then agitated in order to break up the curd into fine particles.

Buttermilk is often used as a beverage, and has much the same food value as skim milk. An ordinary glass would contain about as much nourishment as two ounces of bread, a good-sized potato, or a half pint of oysters. To many persons buttermilk is as palatable as, or even more palatable than, whole or skim milk, but others find the sour taste very unpleasant. This sour taste is due mainly to lactic acid, and does not make the buttermilk less digestible. On the contrary, its casein forms a more flaky curd than that of ordinary milk. Buttermilk is frequently fed to babies, especially in Holland, and is sometimes prescribed when the protein of ordinary milk proves indigestible. Its general use is increasing in this country. Buttermilk ice cream is considered a delicacy in some sections, especially for invalids.

[5] U. S. Dept. Agr. Bul. 469 (1916), Fats and Their Economical Use in the Home.

Condensed buttermilk, for use as such, is manufactured to some extent, and considerable quantities are condensed and dried for use in bakeries.

CHEESE.

Cheese consists of the casein of milk and more or less fat and mineral constituents which are precipitated with the casein when rennet is added to milk. There are numerous varieties of cheese made, not only from cow's milk but also from that of goats, sheep, and other animals. The flavor is due chiefly to the action of ferments, of bacteria, or of molds.

The literature of food and nutrition contains little definite information regarding the digestibility of cheese, but there is a general opinion that this food, particularly the very strong varieties, is less easily digested than most milk products. As regards thoroughness of digestion, a very large number of experiments carried on by the Department of Agriculture have shown that, when consumed even in relatively large amounts, cheese is very thoroughly assimilated. Furthermore, it caused no physiological disturbances in the large number of tests in which it was used.

Cheese, containing, as it does, almost all the protein and often most of the fat of the milk from which it is made, and having a comparatively low water content, is a very nutritious food, and the cheaper kinds may well be used more abundantly than is commonly the case in this country as a part of the regular diet and not simply as a condiment at the end of a hearty meal. As a source of calcium, American, or Cheddar, cheese can not be equaled by any other common food. The cost of cheese varies greatly with the kind, but the higher prices are usually paid for distinctive flavor or texture rather than for food values.

Cottage cheese, as commonly made at home from sour milk with or without the cream, is a nutritious and palatable food, as may be seen from figures for its composition in the table on page 22. Under ordinary conditions it is very inexpensive. There are several other kinds of unripened cheeses on the market which are made in large quantities as regular commercial products and sold under such names as Neufchâtel, or, less commonly, cream cheese. Directions for making cottage cheese are given in another bulletin [6] in this series. In many city markets the homemade product may also be purchased. Cottage cheese is a palatable addition to the diet, alone or seasoned in various ways, and is also used in the preparation of a number of dishes, recipes for which are given in another publication of this department.[7]

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[6] U. S. Dept. Agr., Farmers' Bul. 850, How to Make Cottage Cheese on the Farm.

[7] U. S. Dept. Agr., Dept. Circ. 109, Cottage Cheese Dishes.

WHEY.

Just as buttermilk represents the residue of milk from butter making, so whey represents what is left from cheese making, and consists mainly of water, milk sugar, and mineral matter. It is less nutritious than skim milk or buttermilk, but it may be used in place of milk or buttermilk in bread making and in various other ways. It is occasionally useful as a mild laxative drink for invalids.

Whey may be made at home by cooking sweet milk with some acid material, such as vinegar, lemon juice, or cream of tartar, or even with sour milk. Such whey differs but little in composition from regular cheese whey. Fresh curds and whey is an old-fashioned dish still used to some extent, though less common than it was when cheese making was regularly carried on as a home industry.

SOUR MILK AND CLABBER.

The lactic-acid bacteria normally present in milk cause it to sour quickly if not held at a low temperature. As the milk coagulates, or curdles, from the effect of the acid, it gradually assumes a semi-liquid form commonly known as "clabber." In many parts of the United States clabber is a common article of diet and is wholesome, and to those who care for it very refreshing and palatable. Its nutritive value does not differ from the milk from which it is made. Usually no special methods are followed in preparing clabber other than allowing the milk to stand undisturbed until coagulation occurs. If the souring takes place too slowly, the clabber may have a bitter or unpleasant flavor due to the development of undesirable bacteria.

Sour milk or clabber is much used in cookery, and adds materially to the nutritive value of the dish of which it forms a part. Before baking powders became so common, sour milk and baking soda were very commonly used to leaven doughs and batters of various sorts. Some cooks maintain that they can get the best results by using only the whey of sour milk, but this naturally gives a less nutritious dish and therefore is not so desirable.

KEPHIR, KOUMISS, AND OTHER FERMENTED-MILK PRODUCTS.

Since earliest times fermented-milk products have been used as beverages and articles of diet in central Asia, Turkey, and other countries. These products are prepared by allowing special ferments or yeasts to develop in milk, and owe their sparkling or effervescent qualities to the carbon dioxid produced by the action of organisms. The flavor differs with the process of manufacture. These fermented-milk beverages have proved very satisfactory in invalid dietetics and are now well known and commonly used. Fermented-milk beverages may be made at home, but are perhaps more commonly commer-

cial products in the United States. In this country cow's milk is almost always used to make these beverages, but mare's and other kinds are more common in central Asia and other regions.

A carbonated milk, which is made by charging milk with carbon dioxid, is sometimes found on sale, but of course lacks the special qualities that all the fermented products contain.

These fermented-milk products contain lactic-acid-forming bacteria in great abundance, and their extensive use has been much discussed recently, owing to the prominence given to the theory that many disorders, particularly those incident to old age, are the results of the development of putrefactive bacteria in the intestine and that the growth of such organisms may be hindered by the presence of lactic acid. The most recent observations, however, make it doubtful whether such soured milk is as beneficial as has been claimed by some enthusiasts.

SPECIAL INFANT FOODS.

Numerous patent infant and invalid foods are on the market, some of which contain cow's milk as a basis combined with varying amounts of carbohydrates or other constituents, and others that seem to be made of farinaceous materials without milk. In some cases the carbohydrates have apparently been malted before being combined with milk, or else malt extract is added during the process of manufacture.

Experience has shown that these special milk foods (when they really contain the nutrients of milk) are sometimes useful and valuable for infants where it is necessary to resort to some method of artificial feeding, but every one recognizes that where possible mother's milk is the best food for the young child. Too much credence should not be given to the extravagant claims made for some brands of infant foods. The safest course is undoubtedly to follow the advice of a competent physician in selecting the substitute for natural feeding. It is often wiser to use modified cow's milk in preference to these commercial foods, and it can be easily prepared at home under a physician's directions, at much less cost, to meet the individual needs of the infant in question.

USE OF MILK IN COOKING.

If freely used in the preparation of other foods, milk can be made to add considerably to the food value of the meals. A dish is, of course, richer if whole rather than skim milk is used, but for the purpose of increasing the food value of the diet skim milk is very valuable because it provides one of the most important nutritive ingredients, that is, the protein. If extra fat is needed, it may be supplied in the form of butter, which is usually a

more economical source than whole milk, or in the form of lard or other culinary fat.

The following suggested ways in which milk may be used in the diet apply to both whole and skim milk.

SOUPS.

Milk soups are an excellent way not only of serving milk, but also of utilizing left-over portions of vegetables and other foods. In making these soups, allow to each cup of liquid (including milk and the juice and pulp of vegetables) from one-half to one level tablespoon of flour and one level tablespoon or more of butter or other fat. Some of the flavorings that may be used are onion, corn, asparagus, cabbage, cauliflower, peas, potatoes, beans, tomatoes, celery, spinach, salmon or other fish, or grated cheese. Very often children who do not like milk to drink will relish it when combined with a favorite vegetable and served as a soup, and in this way may be induced to take the desired amount of milk each day.

CHOWDERS.

Chowders are also a very appetizing way of serving milk. For fish chowders the proportions are 2 cups of milk or of milk and water, 1 cup of potatoes cut into small pieces, and 1 pound of fish. The flavoring is onions and fat fried from salt pork. While these proportions make a rich dish, it is possible to reduce the amount of fish greatly, to leave it out entirely, to use small portions of left-over fish or salt codfish which has been freshened, or to substitute corn for it. Such dishes are palatable and of reasonably high nutritive value, provided the greater part of the liquid used is milk.

GRAVIES AND SAUCES.

A great variety of milk gravies or sauces, thickened with flour and enriched with butter or other fat, may be served with potatoes or other vegetables or poured over toast. The proportions are 2 level tablespoons of flour and 2 level tablespoons of butter to 1 cup of milk for a sauce of medium thickness. To this may be added chipped beef, codfish or other fresh or salt fish, hard-boiled eggs, small portions of chicken or veal, or grated cheese. Milk gravy flavored with cheese makes a good and very nutritious sauce to pour over cauliflower and cabbage or to serve with boiled rice or hominy.

A very good way to serve milk toast is to toast bread very thoroughly and to pour hot milk over it at the time of serving. In serving milk toast in this way all the dishes should be kept very hot. A heavy earthenware pitcher is excellent for serving the hot milk, as it retains heat for a long time.

Sour milk is used to a large extent in cookery and the sour milk itself, or more commonly the sour-milk curd, is considered by many persons a palatable and wholesome dish. Sour cream is also used in many ways in the household in the making of sauces and dressings and in cookery.

DESSERTS.

There is almost no end to the puddings and desserts in which considerable milk may be used. Blancmange is practically flavored milk, jellied with cornstarch, Irish moss, or some similar material, and chilled.

Junket is simply milk curd separated by rennet, as in cheese making, and eaten before the bacteria that give the cheese its flavor, develop. It is prepared by adding rennet to milk and allowing it to stand undisturbed until it thickens or coagulates; that is, until the casein is precipitated. If the process is carefully carried out a thick, custard-like product results. If, however, it is stirred the casein readily breaks up and separates from the whey. There are a number of preparations of rennet on the market designed especially for making junket, all of which seem to give satisfactory results. Served very cold it is a refreshing dessert in hot weather, as are the numerous milk sherbets, frozen custards, and similar desserts in which milk is used.

Sweet curd, made in somewhat the same way as junket, except that the coagulated milk is broken up and strained, may be used as the basis for filling for pies and tarts. To the curd from 1 quart of milk, add 1 level tablespoon of butter, one-quarter of a cup of sugar, the yolks of two eggs, and a few Zante currants, or chopped raisins, and a little nutmeg.

Baked milk, made by cooking sweetened and flavored milk for a long time in a slow oven, is also good. Many different kinds of puddings are made by baking milk with cereals and either molasses or sugar. The cereal may be rice, corn meal, or buttered white or whole-wheat bread.

There are also the custards of which milk and eggs make the basis. Almost all of these desserts, if carefully made, are nutritious, easily digested, and economical. For children and persons of weak digestion the simpler ones, such as blancmange, custard, and cornstarch and rice puddings, are almost indispensable.

SUMMARY.

Milk is one of the most important foods, in spite of the fact that it is about seven-eighths water. With a few exceptions, it excels all other foods in the variety and quality of materials that it furnishes the body, and is suitable for persons of all ages.

The solids of milk comprise protein, fat, sugar, and mineral matter, all in such form that they can be easily utilized in building and repairing the tissues and bones of the body. Milk is far richer in lime, for example, than other common foods, which makes it especially valuable for young children who need lime to build bones and teeth.

Fresh whole milk also contains all three of the vitamines, constituents of certain foods found by scientists to be necessary for the maintenance of health and normal growth. Milk fat is frequently the most readily available source of vitamine A, which children must have in order to grow and develop normally.

The commission on milk standards of the New York milk committee is recommending the general adoption of a standard for milk calling for at least 3¼ per cent fat and 8½ per cent solids. Such a standard is a fair basis from which to judge the quality of market milk and also to regulate the price.

Certified milk is a special grade produced in establishments rigidly inspected and vouched for by a medical milk commission and must therefore conform to a high standard of purity.

Milk is one of the easiest of all foods to digest, for the normal healthy person and for many invalids as well.

For infants cow's milk often needs to be artificially modified so that it more nearly resembles woman's milk, in which the fat globules are much smaller and there is more sugar.

Milk should be kept clean, covered, and cool from the time it is drawn from the cow until it is used, in order to prevent the bacteria in it from developing and causing it to spoil.

Even milk that looks clean may contain germs of such diseases as typhoid fever, tuberculosis, scarlet fever, septic sore throat, and diphtheria, if drawn from diseased cows, if handled by persons carrying the germs of these diseases, or if the utensils and containers are washed in polluted water, or if the milk is contaminated by flies.

Pasteurizing milk, or holding it at a temperature of 145° F. for 30 minutes, is the best practicable method of destroying disease-producing bacteria without producing undesirable chemical changes in the milk itself. Milk for general use or for infant feeding can be successfully pasteurized at home, and this should be done if there is any question about its purity.

The consumer must share with those who produce and handle milk the responsibility of keeping it sweet and pure until used. It must be kept in a clean, cool place free from undesirable odors and put only in scrupulously clean vessels.

The care of the refrigerator plays an important part in the keeping quality of milk stored in it. It should be inspected at least each week and thoroughly cleaned at regular intervals.

Skim milk, although lacking in fat, is a highly nutritious food especially useful in cooking or combining with other foods. It contains practically all the protein, sugar, and mineral matter of the whole milk.

Condensed, evaporated, and dried milk may be used for many purposes in place of fresh milk when the latter is not available. For feeding children they do not, however, entirely take the place of fresh milk and need to be supplemented by fresh green vegetables and fruit juices.

The fat in cream and butter is very thoroughly and easily digested and carries with it relatively large amounts of the necessary growth-promoting vitamine A.

Cheese contains almost all the protein and fat and much of the sugar and mineral matters of the milk from which it is made. Ordinary American, or Cheddar cheese, for example, contains a far higher proportion of calcium than does any other common food.

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